VELVET MESQUITE CARBON AND COMMERCIAL ACTIVATED CARBON IN THE REMOVAL OF MANGANESE (II) IONS FROM AQUEOUS SOLUTION.

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ABSTRACT   *The amount removal of Mn (II) ions by adsorption on VMC and CAC decreases with the increase in initial concentration of Mn (II) ions and it increases with the increase in contact time, dose of VMC and CAC with initial pH of solution. The initial pH of the solution highly controls the extent of removal of Mn (II) ions by VMC and CAC. Freundlich and Langmuir adsorption isotherms are found to be Satisfactory. The adsorption process is found to be first order with the intraparticle diffusion as one of the rate determining steps. The results of the present study conclude that VMC could be used as an alternative low cost adsorbent material for the removal of heavy metal ions in general, manganese (II) ions in particular from industrial effluent.*

Keywords: Velvet Mesquite Carbon (VMC), Manganese (II) Removal, Commercial Activated Carbon (CAC), Adsorption Isotherms.

INTRODUCTION

The development of industrial technology in husbandry and the growing urbanization generate in the nature several pollutants (heavy metals, colorants, and pesticides). Water pollution by heavy metals (Manganese, lead, cobalt, copper, mercury etc.). Constitutes a source of degradation of the environment and actually requires particular interest on both the local and international scale [1-4]. The various processes to remove metal ions from water and wastewater include techniques, like decomposition, coagulation followed by filtration, chemical reduction and precipitation, complex formation, solvent extraction, ion exchange, ion floatation and adsorption. The major disadvantages of many of these processes are the need for high degree of operator skills. Of the various methods for the removal of metal ions from water and wastewater, the adsorption technique is the most commonly used method. Others researchers have demonstrated that different adsorbents have been used for the removal of manganese ions from aqueous solution, some of which are: activated carbon, zeolites, magnetic iron oxide [1, 3, 4].

Although iron is an essential mineral for human, its presence in ground water above a certin limit makes the water un –usable for aesthetic consideration such as metallic taste, odour, staining of laundry and plumping fixtures [8,11,20]. A number of specialized processes have been developed for the removal of metals from water and waste discharges. These unit operation include: chemical precipitation [7,8], coagulation/flocculation[9,10],Ion exchange/solvent extraction[11,12], cementation [13,14], complexation [15,16], electrochemical operation [17], biological operations[18], evaporation[19], filtration[20],membrane process[21] and adsorption [22-26].

Heavy metal ions are highly toxic to human being and living things. The effluents from metal finishing, alloy manufacturing and some other industries like smelters, casting, ceramics, fungicide, pigments and chemical industries, etc., discharge metal ions in the effluents. This necessitates the removal of metal ions especially manganese (II) ions from water. The major ill-effects caused by metal ions are dermatitis, inhibition of enzyme activity, headache, Wilkinson disease, dizziness, nausea and vomiting, chest pain, tightness of chest, dry cough and shortness of breath, rapid respiration, nephratis, cyanosis an extreme weakness. Manganese is also toxic to the brain resulting in neurological disorder similar to Parkinson's disease [5,6]. Therefore, metal ions like manganese (II) ions are to be necessarily removed from the effluents before its discharge. Commercial Activated Carbon (CAC) is widely used as an adsorbent for the removal of metal ions. Despite

the increased use of activated carbon throughout the water and waste water industries, carbon adsorption remains an expensive treatment process and over recent years this has promoted a growing research interest into the search for the low cost alternatives to activated carbon.

Hence the present study was made with an aim to compare the adsorptive capacities of these adsorbent materials and to find out the feasibility of utilizing the low-cost adsorbents such as Velvet Mesquite Carbon as alternative to commercial activated carbon in the removal of metal ions like manganese (II).

MATERIAL AND METHODS

Commercial Activated Carbon (CAC) was received from Merck, India and Velvet Mesquite Carbon (VMC) was obtained from local vendors in dry form. The adsorbent material was thermally activated at 700 C and acid digested with 2N HNO_3, washed, dried and sieved. Manganese (II) sulphate monohydrate (AR) supplied by Merck, India were used as the sources of manganese (II) ions. Adsorption experiments were carried out at room temperature (30 ± 1ºC) under batch mode. Manganese ion concentrations were estimated complexometrically as per literature methods. Effect of various process parameters on the extent of removal of manganese (II) ions was studied. In all the adsorption experiments, the value of percentage removal and amount adsorbed (in mg/g) were calculated using the following relationships:

Percentage removal= 100 (Ci-Ce)/Ci   (1)
Amount adsorbed = (Ci-Ce)/m   (2)

where,

Ci and Ce are initial and final concentration of manganese (II) ions (in mg/L), respectively and m is the mass of adsorbent (VMC and CAC), in g/L. The data were analyzed statistically and interpreted. The values of percentage removal and amount adsorbed were calculated by the standard methods.

RESULTS AND DISCUSSION

EFFECT OF INITIAL CONCENTRATION

The adsorption experiments have been carried out at different experimental conditions and the results obtained are given in Table 1. The effect of initial concentration of manganese (II) ions on the extent of removal (in terms of percentage removal) of manganese (II) ions on VMC and CAC has been studied. The percentage removal decreases with the increase in manganese ion concentration. This indicates that there exists a reduction in immediate solute adsorption, owing to the lack of available active sites required for the high initial concentration of manganese (II) ions.

Table 1. Relative Adsorption Capacity of VMC and CAC in %.

Adsorbent	Identical Experimental condition	Optimum Experimental condition
VMC	83	90
CAC	100	95

EFFECT OF CONTACT TIME

In order to study the kinetics of adsorption of Mn (II) ions the adsorption experiments were carried out at different contact time at optimum ini tial concentration of Mn (II) ions. The percentage removal of Mn (II) ions exponentially increases wi th the increase in contact time. The percentage removal of Mn (II) ions by VMC and CAC exponentially increases initially and reaches a maximum value at 90 min. After 90 minutes the increase in the percentage removal of Mn (II) ions is not significant.

EFFECT OF DOSE

The effect of dose of VMC and CAC on the percentage removal of Mn (II) ions was studied at the optimum initial concentration of Mn (II) ions and optimum contact time. The percentage removal of Mn (II) ions increases with the dose of VMC and CAC. The increase in dose of adsorbent increased the percentage removal of Mn (II) ions. This may be due to the increase in the availability of surface active sites resulting from the increased dose of VMC and CAC and also due to the conglomeration of the adsorbent, especially at higher doses of adsorbent (VMC and CAC).

EFFECT OF INITIAL PH

The adsorption of metal ion is reported to be highly pH dependent. The effect of initial pH on the adsorption of Mn (II) ions was studied at different initial pH values of solution of Mn (II) ions. The process of adsorption of Mn (II) ions on VMC and CAC is found to be highly pH dependent. The increase in pH increases the percentage removal of manganese (II) ions.

The final pH of the solution after adsorption decreases. The similar type of results are presented in many research articles.

ADSORPTION ISOTHERMS

The adsorption data have been analyzed with the help of Freundlich and Langmuir isotherms as per the equations reported in literature (Adamson, 1960):

Freundlich isotherm: $\log 1 = \log K + (1/n) \log C_e$ (3)

Langmuir isotherm: $(C_e/q) = (1/Q_o b) + (C_e/Q_o)$ (4)

where, K and 1/n are the measures of adsorption capacity and intensity of adsorption, respectively; q is the amount of adsorbed per unit mass of adsorbent (in mg/g); Q_o and b are Langmuir constants, which are the measures of monolayer adsorption capacity (in mg/g) and surface energy (in L/mg), respectively.

CONCLUSION

The removal percentage of Mn (II) ions by adsorption on VMC and CAC decrease with the increase in initial concentration of Mn (II) ions and increases with the increase in contact time, dose of VMC and CAC and initial pH of solution. The initial pH of the solution highly effect in the extent of removal of Mn(II) ions by VMC and CAC. Freundlich and Langmuir adsorption isotherms are found to be valid. The adsorption process is found to be first order with the intraparticle diffusion as one of the rate determining steps. The findings in the present study conclude that VMC could be used as an alternative low cost adsorbent material for the removal of heavy metal ions in general, manganese (II) ions in particular from industrial effluent.

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